A Novel Ground-based Microwave Radiometer for High Precision Atmospheric Observations Between 10 and 90 GHz

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State-of-the-art microwave radiometers for probing water vapour. temperature and cloud liquid water do not show the high accuracy and stability which is needed for some applications like radio science or the assessment of turbulent weather conditions. Especially scientific experiments, performed in outer-space and missions to investigate other planets, are dependent upon high-precision transmission of data to receivers on Earth passing through the atmosphere, which is a big source of disturbance.. Propagation and attenuation at frequencies between a few GHz and several tens of GHz are influenced by dry air as well as by water vapour and liquid water in form of clouds and rain. A precise and stable microwave radiometer to derive these properties has been developed – the *Atmospheric Propagation and Profiling System* ATPROP.

ATPROP is able to detect tropospheric profiles of humidity and temperature as well as the integrated humidity. Using elevation scans, high resolution boundary layer temperature profiles can be measured. The possibility of elevation scans as well as azimuth scans enables the three dimensional detection of inhomogenities in clouds and water vapour. The beam can also be targeted on every specified satellite position. For the application of satellite ground stations, retrieval algorithms for calculation of dry and wet path delay and attenuation at different frequencies have been developed and implemented.

The radiometer provides 7 channels on the water vapour- (K-Band) and 7 channels on the oxygen line (V-Band) for detection of humidity and temperature profiles (similar to the *Humidity and Temperature Profiler* (HATPRO)). Two additional channels have been added at the Ku-band (near 15 GHz) and at the W-band (near 90 GHz). The 90 GHz channel enhances the detection of cloud liquid water and (compared to HATPRO) improves the detection of clouds with lower liquid water path. The 15 GHz channel is favourable for detecting the onset of precipitation and quantity of rainfall for most conditions except the heaviest rain events.

The intensity and phase delay of satellite transmissions depends on atmospheric fluctuations as well as technical factors such as orbit instabilities of the spacecraft or thermally driven antenna distortions, etc. These technically related issues extend to time scales of thousands of seconds. Technical and atmospheric fluctuations have to be investigated separately by means of the Allan Standard Deviation to ensure stability and marginal drifts on comparable time scales.

During the testing phase the radiometer was checked for stability under laboratory conditions.

Under these conditions it obeys the so-called “radiometer formula” up to about 10^4 seconds. Measurements of water vapour, liquid water, path delay and attenuation at different frequencies have been performed under outdoor conditions. At the moment ATPROP is deployed in Cabauw / Netherlands (KNMI) and will also be used in conjunction with two other HATPRO radiometers for tomography experiments. Furthermore, the radiometer measurements containing high resolution temperature and humidity profile measurement as well as three dimensional scans of water vapour and liquid water content. The results of these measurements are presented in detail in the current paper. Alike, comprehensive results of the Cabauw field measurements concerning the propagation parameters and the stability treatments will be presented.